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REVIEW

Effectiveness of workplace health promotion and primary prevention interventions: a review

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Abstract
Background Workplace health promotion and primary prevention interventions are highly prevalent. However, their effectiveness remains mostly unclear.
Aim This article compiles and summarizes the results of current reviews concerning the effectiveness of health promotion and primary prevention interventions in the workplace.
Subjects and methods Studies were selected from four electronic databases on the basis of the following criteria: (1) Meta-analysis or systematic reviews, (2) published in international peer-reviewed journals (3) between 1 January 2004 and 30 June 2008 (4) in English or German (5) that examined the effectiveness of workplace health promotion and primary prevention interventions.
Results Seventeen reviews met the inclusion criteria and were subsequently categorized into the following areas of intervention: stress, physical activity and nutrition, organizational development, smoking, and ergonomics and back pain. Singular interventions showed limited effectiveness. Workplace interventions aimed at helping individuals reported substantially greater effects than workplace interventions aimed at the workforce as a whole; here, methodological influences play an important role.
Conclusions The greatest results are achievable through comprehensive multimodal (or systemic) programs including relational and behavioral elements. Future research is needed in the conception of methodologically sound and setting-appropriate study designs.

Keywords Health promotion · Primary prevention · Workplace · Effectiveness · Intervention · Review

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Background and aims

Workplace health promotion and primary prevention interventions have attempted to react to an increasing burden and a changing spectrum of disease as well as—especially from an economic view—high levels of sick leave. The knowledge that at least parts of modern society's diseases are caused primarily by unhealthy behavior, and are therefore preventable, triggered multiple behavioral interventions in the areas of physical activity and nutrition (Ahrens and Schott 2004). Workplace health promotion and primary prevention interventions are highly prevalent. However, their effectiveness remains mostly unclear.

Starting points of health-related interventions are, on the one hand, persons (behavioral prevention) who should be encouraged to healthier lifestyles through increased physical activity, healthier nutrition or improved stress management training. On the other hand, there are starting points applied in the environment (relational prevention). Employee health can also be increased through improved working conditions, a participative leadership or interventions in organizational culture (Ulich and Wülser 2009).

Meanwhile, thousands of research activities on the effectiveness and efficiency of workplace health promotion programs exist, which has been summarized in numerous reviews (e.g., Lehmann et al. 2008; Semmer and Zapf 2004; Sockoll et al. 2008). It is remarkable that the quality of studies and reviews has increased in the course of time, so that the evidence today concerning some interventions can be rated as high (Lehmann et al. 2008).

The present narrative review belongs to this aforementioned series of reviews. The iga-report of Sockoll et al. (2008) has been particularly helpful to prepare this manuscript. However, the present review displays the latest scientific findings. Its aims are to compile and summarize the results of current meta-analysis and systematic reviews concerning the effectiveness of health promotion and primary prevention interventions in the workplace.

Methods

Inclusion criteria

Studies were selected on the basis of the following criteria: (1) Meta-analysis or systematic reviews, (2) published in international peer-reviewed journals (3) between 1 January 2004 and 30 June 2008 (4) in English or German (5) that examined the effectiveness of workplace health promotion and primary prevention interventions. Meta-analysis and systematic reviews that examined the effectiveness of secondary and tertiary prevention interventions as well as all efficiency studies were explicitly excluded from this review.

Search strategy

Four electronic databases were utilized: Cochrane Library, Cochrane Occupational Health Field, Medline via PubMed and EBSCOhost. The terms used in the search were selected according to Verbeek et al. (2005). Especially the terms "effectiveness," "promotion," "prevention," "work," "worksite," "workplace," "occupational," "organisational," "organizational", "wellness," "culture," "stress," "nutrition," "diet," "physical activity" and combinations of these terms were used. The following example will clarify the search strategy. A search on 9 July 2008 of the literature-database Medline via PubMed generated 33 hits including the terms "(work OR worksite OR occupational OR workplace OR organisational OR organizational) AND (promotion OR prevention) AND health AND effectiveness AND (systematic review)" and the restrictions "Field: Text Word, Limits: Publication Date from 2004/01/01 to 2008/06/01, Meta-Analysis, Review, English, German." Of these, three reviews met the inclusion criteria and were therefore added into the present review (Engbers et al. 2005; Matson-Koffman et al. 2005; Van Poppel et al. 2004).

Study selection

Titles and abstracts provided the basis for initial decisions and selection of articles. Eighty-six possibly relevant articles were found. Forty-seven articles (54.7%) did not meet the inclusion criteria: Nine articles examined secondary or tertiary prevention interventions (e.g., back school, rehabilitation), 27 articles were not systematic, and 11 of the systematic reviews examined very special areas and/or settings (carpal tunnel syndrome, disability management). The full texts of the remaining 39 articles (45.3%) were independently screened by a pair of reviewers who then came to a consensus. All articles (15 reviews) that were published before 1 January 2004 were excluded from the review, because updates of earlier articles were available and articles on the same topics showed similar results. Seven of the remaining 24 articles (Ammendolia et al. 2005; Hey and Perera 2005; Katz et al. 2005; Novak et al. 2007; Van der Molen et al. 2005; Van Duijvenbode et al. 2008) were included into the short descriptions of similar but possibly more relevant articles (Bos et al. 2006; Engbers et al. 2005; Matson-Koffman et al. 2005; Moher et al. 2005; Parks and Steelman 2008; Van Poppel et al. 2004). That means that all in all 17 articles (19.8%) met the inclusion criteria, while 69 articles (80.2%) were excluded from the review. The current narrative review consists of three meta-analyses (17.6%) (Parks and Steelman 2008; Richardson and Rothstein 2008; Smedslund et al. 2004) and 14 systematic reviews (82.4%) (Bambra et al. 2007; Bos et al. 2006; Brewer et al. 2006; Egan et al. 2007; Engbers et al. 2005; LaMontagne et al. 2007; Marine et al. 2006; Marshall 2004; Matson-Koffman et al. 2005; Moher et al. 2005; Rivilis et al. 2008; Seymour et al. 2004; Tveito et al. 2004; Van Poppel et al. 2004).

Data analysis

Using the guidelines of Mulrow (1987), the methodological quality of all reviews was assessed as high enough to be included in the current review. Study characteristics were qualitatively extracted. The following data were compared: first author, year, country, review type; number of studies, study designs, sample size; intervention type; outcomes and results. Table 1 follows this structure. Additionally, a rating system of levels of evidence based on previously used best-evidence syntheses was used to determine the effectiveness of interventions. The following five levels were defined: (1) +++ = strong evidence, (2) ++ = moderate evidence, (3) + = limited

evidence, (4) − = no evidence, (5) ✓ = evidence [evidence level not specified (n.s.)].

Results

The results of current reviews concerning the effectiveness of workplace health promotion and primary prevention interventions are summarized and compiled into the following areas of intervention: stress, physical activity and nutrition, organizational development, smoking, and ergonomics and back pain. The main characteristics of the reviews are described in Table 1. All in all, 71 interventions were categorized by their evidence level. Forty-nine interventions (69%) showed evidence, while no evidence was found for 22 interventions (31%). Strong or strong-to-moderate evidence was found for 11 interventions, moderate or moderate-to-limited evidence for 15 interventions, and limited or limited-to-no evidence for 15 interventions. For eight interventions evidence was found; their evidence level was, however, not indicated. The intervention areas are structured by their level of evidence. Ninety-one percent of the stress-related interventions (11 interventions), 78 percent of the physical activity and nutrition interventions (14 interventions), 75 percent of the organizational development interventions (6 interventions), 69 percent of the smoking interventions (9 interventions) and 48 percent of the ergonomics and back pain interventions (10 interventions) showed evidence, while there was no evidence found for the other interventions.

Stress

Three of the included reviews dealt with stress-related interventions at the workplace. Within an update of a meta-analysis of Van der Klink et al (2001), Richardson and Rothstein (2008) explored the effects of occupational stress management intervention programs. Marine et al. (2006) analyzed interventions to prevent occupational stress in health-care workers. LaMontagne et al. (2007) prepared an update of a review of Jordan et al. (2003) concerning the job-stress intervention evaluation literature, 1990–2005. All in all, 145 studies (randomized controlled trails (RCTs), cluster-randomized trials, crossover trials, experimental studies, quasi-experimental studies and studies without comparison group) were quantitatively or qualitatively analyzed within the meta-analysis of Richardson and Rothstein (2008) and the two systematic reviews. Different individual-level outcomes (e.g., general mental health, somatic symptoms, job/work satisfaction) and organization-level outcomes (e.g., absenteeism, productivity, injury rates) were evaluated. Eleven interventions were categorized by their evidence level. The articles show consistent results. The effectiveness of stress management interventions could be proven in all three reviews. Cognitive-behavioral interventions showed the greatest effectiveness, and relaxation interventions were most commonly used. The reviews showed that greater results can be achieved with educational interventions than with rational interventions. Especially the redesign of work, the reduction of work demands, improved communication and the development of conflict management skills offer great potential for employee health. Two interventions showed strong evidence, one showed strong to moderate evidence, three interventions displayed moderate evidence, four displayed limited evidence, and only one showed no evidence. Strong evidence was found in the meta-analysis of Richardson and Rothstein (2008) for cognitive-behavioral interventions [d=1.164 significant (s.)] and "alternative" interventions, e.g., EMG feedback, journaling and personal skills development (d=0.909 s.). The overall weighted effect size for all studies showed a significant medium to large effect (d=0.526 s.). Relaxation interventions showed moderate effects (d=0.497 s.). Also, organizationally focused moderate as well as individually and organizationally focused high-rated approaches showed moderate effects in LaMontagne et al. (2007). Limited evidence was found in Richardson and Rothstein (2008) for multimodal interventions (d=0.239 s.), in Marine et al. (2006) for the effectiveness of person-directed (SMD=−0.85 s.) and work-directed stress reduction interventions (MD=−0.34 s.) and in LaMontagne et al. (2007) for individually-focused low-rated approaches. No evidence was found for organizational interventions [d=0.144 non-significant (n.-s.)] in Richardson and Rothstein (2008).

Physical activity and nutrition

Five of the included reviews dealt with physical activity and/or nutrition. Three of them determined comprehensive programs, including both physical activity and nutrition. Parks and Steelman (2008) examined the effectiveness of fitness-oriented as well as comprehensive organizational wellness programs. Engbers et al. (2005) analyzed worksite health promotion programs with environmental changes. Matson-Koffman et al. (2005) did a site-specific literature review of policy and environmental interventions that promoted physical activity and nutrition for cardiovascular health. The other two reviews only determined either physical activity or nutrition. Within an update of a meta-analysis of Dishman et al. (1998), Marshall (2004) searched for challenges and opportunities for promoting physical activity in the workplace. Seymour et al. (2004) analyzed the impact of nutrition environmental interventions on point-of-purchase behavior in adults. In total, 229 studies RCTs, [randomized trials (RTs)], controlled trials (CTs), experimental, quasi-

Table 1 Reviews of effectivity studies on stress, physical activity and nutrition, organizational development, smoking, and ergonomics and back pain

Authors (year), country, review type	Number of studies, study designs, sample size	Intervention types	Outcomes	Results
Bambra et al. (2007) UK, Europe Systematic review	19 Studies (14 Prospective cohort studies, 5 repeat cross-sectional studies) n=3,515	Task restructuring "micro-level" interventions: -Task variety (primary nursing, production line) -Team working -Autonomous groups ("lean production", "just-in-time" production, autonomous work groups)	-Psychosocial outcomes (self-reported demand, control and support or related measures, e.g., work complexity, autonomy, satisfaction with colleagues) -Health outcomes (self-reported physical health, mental health, absenteeism and physical measures)	Evidence of the effectiveness of task variety on: -The psychosocial work environment: + -Health: +/− Evidence of the effectiveness of team working on: -The psychosocial work environment: + -Health: − Evidence of the effectiveness of autonomous groups on: -The psychosocial work environment: + resp. ↓ -Health: + resp. ↓
Bos et al. (2006) The Netherlands, Europe Systematic review	13 Studies (3 RCTs, 8 CTs, 2 non-controlled trials) n=~ 2,416	Occupational interventions on reduction of musculoskeletal symptoms: -Ergonomic interventions (e.g., redesign of a workplace) -Behavioral interventions (e.g., physical exercise, education, training) -Organizational interventions (e.g., work procedures)	-Economic outcomes (absenteeism due to musculoskeletal problems) -Health outcomes (musculoskeletal symptoms, fatigue, physical discomfort, perceived physical load) -Ergonomic outcomes (technical performance of transfers, frequency of manual lifting, knowledge about risk factors at work and ergonomic principles)	Evidence of the effectiveness of occupational interventions on reduction of musculoskeletal symptoms in the nursing profession: -Physical discomfort: +++ -Technical performance of transfers: +++ -Frequency of manual lifting: +++ -Absenteeism due to musculoskeletal problems: − -Musculoskeletal symptoms: − -Fatigue: − -Perceived physical load: − -Knowledge about risk factors at work and ergonomic principles: −
Brewer et al. (2006) Texas, USA Systematic review	31 Studies (23 RCTs, 8 non-randomized trials) n=u.i.	Workplace interventions to prevent musculoskeletal and visual symptoms and disorders among computer users: -Trainings (e.g., exercise, stress management, ergonomics) -Workstation adjustment (e.g., lightening, rest breaks)	-Musculoskeletal outcomes n.s. -Visual outcomes n.s.	Evidence of the effectiveness of: -Workstation adjustment: − -Rest breaks together with exercise: − -Alternative pointing devices: ++ to prevent musculoskeletal and visual symptoms and disorders among computer users

		-New equipment (e.g., new chair, arm supports, screen filters, alternative pointing devices, keyboards)		
Egan et al. (2007) UK, Europe Systematic review	18 Studies (12 Prospective studies with non-randomized comparison group, 3 uncontrolled prospective, 3 retrospective studies) n=4,147	"Macro-level" interventions that aim to increase employee control: -Single-interventions (employee committees to identify workplace stressors and ways to reduce them) -Multi-interventions (employee committees combined with individual-level health promotion, education and behavior interventions, e.g., physical activity)	-Psychosocial outcomes (self-reported demand, control and support or related measures, e.g., work complexity, autonomy, satisfaction with colleagues) -Health outcomes (self-reported physical health, mental health, absenteeism and physical measures)	Evidence of the effectiveness of organization-level participation interventions: -Deterioration on employee health: − -Benefit to employee health: +
Engbers et al. (2005) The Netherlands, Europe Systematic review	13 Studies (11 RCTs, 2 CTs quasi-exp.) n~44,492	Multi-component interventions with particularly environmental strategies [mix of incentives, information to raise awareness, education and counseling, policy change (on smoking), family counseling]: -On physical activity (e.g., new fitness facilities, existing facilities upgraded with new fitness machines, use of stairs) -On healthy eating (e.g., food labeling at point of purchase, availability of healthy products or enhanced visibility, healthy food offerings in vending machines)	-Physical activity -Dietary intake (fruit, vegetable, and fat intake) -Health risk indicators (cholesterol levels, blood pressure, body mass index)	Evidence of the effectiveness of workplace health promotion programs with environmental modifications to: -Physical activity: − -Health risk factors: − -Dietary intake: +++

Table 1 (continued)

Authors (year), country, review type	Number of studies, study designs, sample size	Intervention types	Outcomes	Results
LaMontagne et al. (2007) Victoria, Australia Systematic review	90 Studies (27 exp., 32 quasi-exp., 31 studies without comparison group) n=n.s.	Job-stress interventions: -Low-rated approaches (individually-focused interventions) -Moderate-rated approaches (organizationally-focused interventions) -High-rated approaches (individually- and organizationally-focused interventions)	-Individual-level outcomes [somatic symptoms, physiologic changes (e.g., blood pressure, cholesterol levels), skills (e.g., coping ability), and psychological outcomes (e.g., general mental health, anxiety)] -Organization-level outcomes (e.g., absenteeism, turnover, injury rates, productivity)	Evidence of the effectiveness of: -Individually-focused low-rated approaches: + -Organizationally-focused moderate-rated approaches: ++ -Individually- and organizationally-focused high-rated approaches: ++
Marine et al. (2006) Finland, Europe Systematic review (Cochrane)	19 Studies (14 RCTs, 3 cluster-randomized trials, 2 crossover trials) n=1,564 (intervention group) n=1,248 (control group)	Preventing occupational stress in health-care workers through: -Person-directed interventions (cognitive-behavioral, relaxation, music-making, therapeutic massage, multi-component) -Work-directed interventions (attitude change and communication, support from colleagues and participatory problem solving and decision-making, changes in work organization)	-Stress -Burnout -Anxiety -General health complaints	Evidence on the effectiveness of: -Person-directed interventions to reduce stress SMD (stress)=−0.85 (95% CI −1.21; −0.49; s.): + -Work-directed interventions to reduce stress MD (stress)=−0.34 (95% CI −0.62; −0.06 s.): +
Marshall (2004) Queensland, Australia Systematic review	32 Studies (5 RCTs, 6 RTs, 7 CTs quasi-exp., 14 cohort studies non-exp.) n=n.s.	Promoting physical activity in the workplace through: -Multiple strategy interventions on physical activity that targeted single or multiple risk factors (e.g., health checks, education programs, motivational prompts to be more active, workplace	Changes in physical activity (n.s.)	Evidence of the effectiveness of multi-strategy interventions on physical activity: -Single risk factor intervention programs d=0.40 (95% CI n.-s.): ++ -Multiple risk factor intervention programs d=0.24 (95% CI n.-s.): + -Health checks: − -Incentive-based programs: −

		exercise programs, incentive-based programs or some combination of these, individual counseling, self-directed behavior change)		-Educational programs: ✓ -Motivational prompts d=0.34 (95% CI n.-s.): ++ -Workplace exercise programs d=0.37 (95% CI n.-s.): ++ -Individual counselling d=0.40 (95% CI n.-s.): ++
Matson-Koffman et al. (2005) Georgia, USA Systematic review	129 Studies (42 were conducted in worksites) (n.s.) n=u.i.	Policy and environmental approaches to improve physical activity and nutrition: -Physical-activity interventions (e.g., incentives, environmental prompts to use stairs, safety tips, and other behavioral strategies to increase stair-climbing, exercise facilities on-site or rented, on-site shower, locker facilities) -Nutrition interventions [e.g., increased availability of healthy foods, healthy food offerings in vending machines and cafeterias, food labeling (point of purchase)]	-Behavioral change -Physiological change -Organizational change	Evidence of the effectiveness of policy and environmental approaches on: -Physical activity: ✓ -Nutrition: ✓
Moher et al. (2005) UK, Europe Systematic review (Cochrane)	64 Studies (31 CTs, 33 CTs) n=u.i.	Workplace interventions for smoking cessation: -Workplace interventions aimed at helping individuals to stop smoking (group therapy, individual counseling, self-help materials, nicotine replacement therapy) -Workplace interventions aimed at the workforce as a whole to	-Quit rates	Evidence of the effectiveness of workplace smoking cessation programs: -Group therapy: +++ -Individual counseling: +++ -Nicotine replacement therapy: +++ -Self-help materials: ++ -Tobacco bans: + -Social support: − -Environmental support: − -Competitions and incentives: +

Table 1 (continued)

Authors (year), country, review type	Number of studies, study designs, sample size	Intervention types	Outcomes	Results
		stop smoking (tobacco bans, social support, environmental support, competitions and incentives, comprehensive programs)		-Comprehensive (multi-component) programs: −
Parks and Steelman (2008) Florida, USA Meta-analysis	17 Studies (Exp., quasi-exp.) n=7,705 (Absenteeism) n=2,480 (Job satisfaction)	Organizational wellness programs: -Fitness-oriented wellness programs -Comprehensive wellness programs including both a fitness component and an educational component	-Absenteeism -Job satisfaction	Evidence of the effectiveness of organizational wellness programs on: -Absenteeism d=−0.30 (95% CI −0.48; −0.22; p<0.00; s.): ++/+ -Job satisfaction d=0.42 (95% CI 0.05; 0.08; p<0.03; s.): ++
Richardson and Rothstein (2008) New York, USA Meta-analysis	36 Studies (36 CTs) n=2,847	Occupational stress management intervention programs: -Cognitive-behavioral interventions -Relaxation interventions -Organizational interventions -Multimodal interventions -"Alternative" interventions (e.g., EMG feedback, journaling, personal skills development)	-Psychological measures (e.g., stress, anxiety, general mental health, job/work satisfaction) -Physiological measures (e.g., blood pressure, (nor)epinephrine level, galvanic skin response, cholesterol) -Organizational-specific outcomes (e.g., absenteeism, productivity)	Evidence of the effectiveness of: -Stress management interventions (total) d=0.526 (95% CI=0.364; 0.687; s.): +++/++ -Cognitive-behavioral interventions d=1.164 (95% CI 0.456; 1.871; p<0.01; s.): +++ -Relaxation interventions d=0.497 (95% CI 0.309; 0.685; p<0.001; s.): ++ -Organizational interventions d=0.144 (95% CI −0.123; 0.411; n.-s.): − -Multimodal interventions d=0.239 (95% CI 0.092; 0.386; p<0.01; s.): + -"Alternative" interventions d=0.909 (95% CI 0.318; 0.499; p<0.01; s.): +++

Rivilis et al. (2008) Canada, North America Systematic review	12 Studies (Pre-post designs) n=~ 7,879	Participatory ergonomic changes in: -Workplaces and equipment -Work tasks -Job teams -Work organization	-Pain/discomfort -Musculoskeletal symptoms -Injury rates -Accident/first aid rates -Absenteeism -Sick leave -Work function/limitation	Evidence of the effectiveness of participatory ergonomic interventions on: -Musculoskeletal symptoms: ++ -Reduction in injuries and workers' compensation claims: + -Reduction in lost days from work or sickness absence: +
Seymour et al. (2004) Georgia, USA Systematic review	38 Studies (10 were conducted in worksites) (n.s.) n=n.s.	Nutrition and environmental interventions on point-of-purchase behavior in adults through: -Environmental and policy nutrition interventions (food availability, access, pricing, or information at the point-of-purchase in vending machines and cafeterias)	-Sales data -Dietary assessment -Physiological changes (e.g., blood pressure)	Evidence of the effectiveness of: -Information strategies: +++ -Combined strategies: ++ -Incentives: +
Smedslund et al. (2004) Norway, Europe Meta-analysis	19 Studies (9 RCTs, 10 CTs) n=9,692	Workplace interventions for smoking cessation: -Workplace interventions aimed at helping individuals to stop smoking (self help manuals, physician advice, health education, cessation groups) -Workplace interventions aimed at the workforce as a whole to stop smoking (incentives, competitions)	Quit rates: -Follow-up at 6 months -Follow-up at 12 months -Follow-up at more than 12 months	Evidence of the effectiveness of workplace smoking cessation programs: -At 6-month follow-up OR=2.03 (95% CI 1.42; 2.90; s.): ✓ -At 12-month follow-up OR=1.56 (95% CI 1.17; 2.07; s.): ✓ -At more than 12-months follow-up OR=1.33 (95% CI 0.95; 1.87, n.-s.): − -Quit rates (total): QR=18% (28 comparisons): ✓
Tveito et al. (2004) Norway, Europe Systematic review	31 Studies (31 CTs) n=~ 11,191	Low back pain interventions at the workplace: -Preventive interventions (educational, exercise, back belts, comprehensive multidisciplinary, pamphlet) -Treatment interventions	-Sick leave -Costs -Number of new episodes of back pain -Level of pain	Evidence of the effectiveness of exercise resp. comprehensive multidisciplinary interventions on: -Sick leave: ✓ resp. − -Costs: ✓ resp. − -Number of new episodes of back pain: ✓ resp. − -Level of pain: − resp. ✓

Table 1 (continued)

Authors (year), country, review type	Number of studies, study designs, sample size	Intervention types	Outcomes	Results
Van Poppel et al. (2004) The Netherlands, Europe Systematic review	15 Studies (10 RCTs, 5 CTs) n=12,756	Primary prevention of back pain at the workplace: -Lumbar supports -Education -Exercise	-Incidence of persons with back pain -Prevalence of persons with back pain -Number of days with back pain or a composite score for back pain -Work loss	Evidence of the effectiveness of: -Lumbar supports: – -Education: – -Exercise: + in the primary prevention of back pain in the workplace

CI = confidence interval, CT = controlled trial, d = Cohen's d (standardized mean effect size), exp. = experimental, n = sample size, n.-s. = non-significant, n.s. = not specified, OR = odds ratio, p = p-value, QR = quit rate, RCT = randomized controlled trial, RT = randomized trial, s. = significant, u.i. = unclear information, – = no evidence, ✓ = evidence (evidence level n.s.), (S)MD = (standardized) mean difference, + = limited evidence, +/– = limited to no evidence, ++ = moderate evidence, ++/+ = moderate to limited evidence, +++ = strong evidence, +++/++ = strong to moderate evidence, ↓ = deterioration

experimental, non-experimental studies were quantitatively or qualitatively evaluated within the meta-analysis of Parks and Steelman (2008) and the four systematic reviews. Different outcomes concerning physical activity and nutrition (e.g., physiological change, behavioral change, organizational change, absenteeism, job satisfaction) were evaluated. Eighteen interventions were categorized by their evidence level. Two of them showed strong evidence, six showed moderate evidence, one displayed moderate to limited evidence, and two showed limited evidence. Evidence was found for three interventions, though their evidence level was not indicated. No evidence was found for four interventions. It can be concluded that in the workplace setting a combination of physical activity and nutrition interventions shows the greatest effects in preventing morbidity and mortality caused by overweight [Note: Katz et al. (2005) arrived at the same result.] as well as to reduce absenteeism and increase job satisfaction. Yet, relatively simple measures (e.g., information strategies, motivational prompts to be more active) are appropriate to improve diet and physical activity. The greatest results can be achieved with comprehensive programs, including relational and behavioral elements that are oriented on theories of behavior change and that consider organizational culture as well as individual needs. [Note: Additionally, Novak et al. (2007) give three other "factors of success" for workplace programs: large numbers of employees, multiple risk factors and incorporated occupational safety components.] In Engbers et al. (2005), workplace health promotion programs with environmental modifications showed strong effects on dietary intake and, in Seymour et al. (2004), information strategies showed strong effects on the point-of-purchase behavior in adults. Moderate evidence was found in Marshall (2004) for single risk factor intervention programs [d=0.40 confidence interval (CI) n.-s.], motivational prompts (d=0.34 CI n.-s.), workplace exercise programs (d=0.37 CI n.-s.) and individual counseling on physical activity (d=0.40 CI n.-s.) as well as in Seymour et al. (2004) on the effectiveness of combined strategies on the point-of-purchase behavior. Parks and Steelman (2008) also found moderate evidence for the effectiveness of organizational wellness programs on job satisfaction (d=0.42 s.) and moderate to limited evidence for their effectiveness on absenteeism (d=−0.30 s.). Limited evidence was found in Seymour et al. (2004) on the effectiveness of incentives on the point-of-purchase behavior and in Marshall (2004) on the effectiveness of multiple risk factor intervention programs on physical activity (d=0.24 CI n.-s.). The author also found evidence for the effectiveness of educational programs, and Matson-Koffman et al. (2005) found evidence for the effectiveness of policy and environmental approaches on physical activity and nutrition; unfortunately, the author did not indicate the evidence level. However, Engbers et al. (2005) found

either inconclusive or no evidence of the effectiveness of workplace health promotion programs with environmental modifications on physical activity and health risk factors. Health checks and incentive-based programs on physical activity showed no effects in Marshall (2004) either.

Organizational development

Two of the included reviews explicitly determined that organization-level interventions promote employee health and organizational development. Egan et al. (2007) examined the health and psychosocial effects of increasing employee participation and control through workplace reorganization ("macro-level" interventions). Bambra et al. (2007) determined the health and psychosocial effects of task restructuring interventions through workplace reorganization. The "demand-control-support" model of workplace health (Karasek 1979; Karasek and Theorell 1990) represents the theoretical basis of their work. Altogether 37 controlled and uncontrolled studies were qualitatively analyzed within the two systematic reviews. All studies evaluated psychosocial (e.g., work complexity, autonomy) and health outcomes (e.g., absenteeism, physical measures), mostly on a self-reported basis. Eight interventions were categorized by their evidence level. Egan et al. (2007) examined single-interventions (employee committees) and multi-interventions (employee committees combined with individual-level health promotion, education and behavior interventions). They identified limited evidence suggesting that some organization-level participation interventions may benefit employee health, as predicted by the "demand-control-support" model, but may not protect employees from generally poor working conditions. Moreover, they found no evidence suggesting that organization-level participation interventions may deteriorate employee health. Particularly when employee control improved, demands decreased or support increased, health benefits (especially beneficial effects on mental health, including reduction in anxiety and depression) appeared. According to the "demand-control-support" model, Bambra et al. (2007) discerned three types of task restructuring: task variety (primary nursing, production line), team working and autonomous groups ("lean production," "just-in-time" production, autonomous work groups). Those interventions that improved the psychosocial work environment by increasing task variety either had no effect or had a limited positive effect on health. The team working interventions tended to improve the psychosocial work environment in most studies, but the health effects were less apparent. The autonomous work groups, contrary to the stated aims of such interventions, caused deterioration in the psychosocial work environment, and, as would be expected from the "demand-control-support" model, the resulting health effects were correspondingly adverse, though in some cases they were negligible. For this, Bambra et al. (2007) have some possible explanations: (1) other factors that counteract the health promoting potential of autonomy were stronger, (2) autonomy promoting measures were implemented incompletely or (3) these measures were not implemented in enough depth from the beginning. Reservedly, Egan et al. (2007) point out that interventions to increase employee control may not protect employees from generally poor working conditions. In conclusion, the authors of both reviews mention that many studies show methodological limitations and that the evidence base of the "demand-control-support" model remains only partial.

Smoking

Two of the included reviews dealt with smoking. Moher et al. (2005) as well as Smedslund et al. (2004) examined the effectiveness of workplace smoking cessation programs. All in all, 83 studies (RCTs and CTs) were quantitatively or qualitatively analyzed within the systematic review of Moher et al. (2005) and the meta-analysis of Smedslund et al. (2004), in which the findings were compared with findings of an older meta-analysis by Fisher et al. (1990). Quit rates at various follow-up points were evaluated. Thirteen interventions were categorized by their evidence level. Three of them showed strong evidence, one showed moderate evidence, and two displayed limited evidence. For three interventions, evidence was found; indeed, their evidence level was not indicated. No evidence was found for four interventions. The results show that there is strong evidence available about proven behavioral interventions for smoking cessation (e.g., counseling). Despite strong theoretical arguments for rational interventions (e.g., tobacco bans), their evidence base is unclear, because no effects were detected in the reviews. Moher et al. (2005) found strong evidence for the effectiveness of group therapy, individual counseling and nicotine replacement therapy, moderate evidence on the effectiveness of self-help materials and limited evidence for the effectiveness of tobacco bans and competitions and incentives to stop smoking organized by the employer. Smedslund et al. (2004) found a quit rate of around 18% in the intervention groups, but, as expected, the effect seemed to decrease over time and was not present beyond 12 months. [Note: Smedslund et al. (2004) as well as Hey and Perera (2005) found that competitions and incentives are appropriate to improve participation rates in cessation programs, but not quit rates.] That means that the authors found evidence on the effectiveness of workplace smoking cessation programs at both 6- [Odds ratio (OR)=2.03] and 12-month follow-ups (OR=1.56 s.); however, the evidence level was not indicated. Moher et al. (2005) found no evidence on the effectiveness of either social or environmen-

tal support to stop smoking or comprehensive (multicomponent) programs. As previously noted, Smedslund et al. (2004) found no evidence of the effectiveness of workplace smoking cessation programs at more than 12-month follow-up (OR=1.33, n.-s.).

Ergonomics and back pain

Five of the included reviews dealt with ergonomics and/or back pain. Rivilis et al. (2008) examined the effectiveness of participatory ergonomic interventions on health outcomes. Brewer et al. (2006) analyzed workplace interventions to prevent musculoskeletal and visual symptoms and disorders among computer users. Bos et al. (2006) determined the effects of occupational interventions on the reduction of musculoskeletal symptoms in the nursing profession. Tveito et al. (2004) assessed the effect of controlled workplace interventions on low back pain, and Van Poppel et al. (2004) prepared an update of a review of Van Poppel et al. (1997) concerning the evidence for the evidence for the effectiveness of primary prevention of back pain at the workplace. All totaled, 102 studies (RCTs, CTs, non-randomized trials, non-controlled trials and pre-post designs) were qualitatively analyzed within the five systematic reviews. Different economic (e.g., absenteeism, sick leave), health (e.g., musculoskeletal symptoms, pain) and ergonomic outcomes (e.g., technical performance of transfers) were evaluated. Twenty-one interventions were categorized by their evidence level. Three of them showed strong evidence, two showed moderate evidence, and three showed limited evidence. For two interventions, evidence was found, but their evidence level was not indicated. The rest demonstrated no evidence. It can be concluded that there is inconsistent evidence for singular interventions (e.g., ergonomics training, back school) and outcomes (e.g., absenteeism). The greatest effects can be achieved with combined interventions—consisting of workplace interventions aimed at helping individuals and those aimed at the workforce as a whole (Bos et al. 2006; Silverstein and Clark 2004; Van Poppel et al. 2004). Strong evidence was found in Bos et al. (2006) on the effectiveness of physical discomfort, technical performance of transfers and the frequency of manual lifting on the reduction of musculoskeletal symptoms in the nursing profession. Moderate evidence was found in Brewer et al. (2006) on the effectiveness of alternative pointing devices to prevent musculoskeletal and visual symptoms and disorders among computer users and in Rivilis et al. (2008) on the effectiveness of participatory ergonomic interventions on musculoskeletal symptoms. In the same review, participatory ergonomic interventions on the reduction in injuries and workers' compensation claims as well as in days of work lost or sick leave showed limited effects. Tveito et al. (2004) found evidence that exercise influences sick leave, costs and the number of new episodes of low back pain, but no evidence was found that exercise influenced the level of pain. As for comprehensive multidisciplinary interventions, the authors found evidence concerning the level of pain, but not sick leave, costs and the number of new episodes of low back pain. However, no evidence was found for the effectiveness of workstation adjustment as well as rest breaks together with exercise to prevent musculoskeletal and visual symptoms and disorders among computer users in Brewer et al. (2006). Additionally, no evidence was found in Bos et al. (2006) for the effectiveness of reduced absenteeism due to musculoskeletal problems, musculoskeletal symptoms, fatigue, perceived physical load and the knowledge about risk factors at work and ergonomic principles. Finally, Van Poppel et al. (2004) found no evidence of the effectiveness of lumbar supports and education in the primary prevention of back pain at the workplace. [Notes: Silverstein and Clark (2004) support combinations of measures, consisting of individually focused and organizationally focused interventions, because they appear to have the greatest effect in reducing work-related musculoskeletal disorders. Van der Molen et al. (2005) also support combined interventions (e.g., participative-educational approaches and technical support) to reduce physical work demands and musculoskeletal symptoms. Van Duijvenbode et al. (2008) found similar results. Hence, it is still unclear if lumbar supports are more effective than other interventions for the treatment of lower back pain compared to no interventions at all. There was moderate evidence that lumbar supports are not more effective than no intervention or prevention training at all. Ammendolia et al. (2005) determined that there is currently no conclusive evidence to support the use of back belts to prevent or reduce lost time from occupational lower back pain.]

Discussion

Future research is needed to develop the concepting of methodologically sound and setting-appropriate study designs as well as in a thorough analysis, design, implementation and evaluation of workplace health promotion programs. The discussion of whether relational interventions or behavioral interventions are more effective should be reconsidered. The scientific literature shows that with comprehensive multimodal (or systemic) programs—including relational and behavioral elements—the greatest results can be achieved.

Evidence-based and health-related interventions, both valid for practice and science, are in many cases problem-

atic: the more complex the interventions are, the greater their probability for success, but so too the greater the methodological difficulties in proving a valid success (Pigeot et al. 2006; Thomson et al. 2004). Contrary to relational interventions, behavioral measures are normally easier to standardize. Hence, these measures can be more easily evaluated in experimental study designs, which may be, among other things, due to the fact that their proportion of studies in total is greater than that of health-incriminating relations, which should be changed (Ahrens et al. 2008). This does not mean that relational measures could not be evaluated, but merely that other evaluation designs are needed. Following the logic of the clinical epidemiology, a design of cluster randomization would at first be obvious (e.g., Nijs et al. 2006). In this, not individual test subjects, but rather organizations are randomized to an intervention group and a control group; of course, it has to be ensured that organizations are comparable. A glance into the organizational-scientific literature raises doubts at this point. For example, the social and business organization and management research shows that organizational cultures can be entirely different. Consequently, their access to workplace health promotion programs—especially those in the realm of organizational development—is probably different (Goldgruber 2008). Furthermore, a multiplicity of organizations is needed to statistically neutralize organization-individual confounders.

However, also within behavioral intervention forms, negative correlations exist among standardization, evaluation and generalization. Just the comparison of multimodal programs and singular interventions clarifies this problem. Although it can be shown that multimodal programs can apparently be more successful than those that simply include singular—educational—interventions, it is no longer obvious which components in what dose (e.g., frequency) should be applied.

Not least of all, from a health-economic view, this is yet again problematic, because we can assume that multimodal programs are simply more complex than singular interventions (Ahrens and Schott 2004). Several authors (e.g., Elkeles 2006; Kolip 2006; McQueen 2001; Trojan 2006) have rightly noted that workplace health promotion programs normally represent complex social interventions that can seldom be standardized, regularly have to adapt to different environmental conditions, and hence probably cannot be evaluated reasonably through clinical evaluation methods.

It is necessary to analyze the organization—particularly its culture—before starting a workplace health promotion program. Generally speaking, workplace health promotion interventions are possible in every organization. But it is essential to adjust the interventions to the specific needs of the individual organization. According to the type of organization, different ratios of relational and behavioral elements are effective, whereas the interventions, ideally in terms of comprehensive workplace health management, should be implemented at the management level of the organization.

In conclusion, it should be highlighted that workplace health promotion activities must definitely be continued, because studies such as those included in the present review show that workplace health promotion interventions are not only feasible, but also effective.

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References

Ahrens D, Schott T (2004) Arbeitsbedingte Erkrankungen und betriebliches Gesundheitsmanagement—eine betriebswirtschaftliche und gesundheitsökonomische Betrachtung. Expertise für die Expertenkommission "Betriebliche Gesundheitspolitik" der Bertelsmann Stiftung und der Hans-Böckler-Stiftung. In: Bertelsmann Stifung, Hans Böckler-Stiftung (eds) Zukunftsfähige betriebliche Gesundheitspolitik. Vorschläge der Expertenkommission. Bertelsmann Stiftung, Gütersloh, pp 1–69

Ahrens D, Goldgruber J, Erfkamp H (2008) Evidenzbasierung in Gesundheitsförderung und Prävention. Soziale Sicherheit 2:85–93

Ammendolia C, Kerr MS, Bombardier C (2005) Back belt use for prevention of occupational low back pain: A systematic review. JMPT 28:128–134. doi:10.1016/j.jmpt.2005.01.009

Bambra C, Egan M, Thomas S, Petticrew M, Whitehead M (2007) The psychosocial and health effects of workplace reorganisation. 2. a systematic review of task restructuring interventions. J Epidemiol Community Health 61:1028–1037. doi:10.1136/jech.2006.054999

Bos EH, Krol B, van der Star A, Groothoff JW (2006) The effects of occupational interventions on reduction of musculoskeletal symptoms in the nursing profession. Ergonomics 49:706–723. doi:10.1080/00140130600578005

Brewer S, Van Eerd D, Amick BC III, Irvin E, Daum KM, Gerr F, Moore S, Cullen K, Rempel D (2006) Workplace interventions to prevent musculoskeletal and visual symptoms and disorders among computer users. a systematic review. J Occup Rehabil 16:325–358. doi:10.1007/s10926-006-9031-6

Dishman RK, Oldenburg B, O'Neal H, Shephard RJ (1998) Worksite physical activity interventions. Am J Prev Med 15:344–361. doi:10.1016/S0749-3797(98)00077-4

Egan M, Bambra C, Thomas S, Petticrew M, Whitehead M, Thomson H (2007) The psychosocial and health effects of workplace reorganisation. 1. a systematic review of organisational-level interventions that aim to increase employee control. J Epidemiol Community Health 61:945–954. doi:10.1136/jech.2006.054965

Elkeles T (2006) Evaluation von Gesundheitsförderung und Evidenzbasierung. In: Bödeker W, Kreis J (eds) Evidenzbasierung in Gesundheitsförderung und Prävention. Wirtschaftsverlag NW, Bremerhaven, pp 111–153

Engbers LH, van Poppel MNM, Paw MJM Chin A, van Mechelen W (2005) Worksite health promotion programs with environmental changes. a systematic review. Am J Prev Med 29:61–70.

Fisher KJ, Glasgow RE, Terborg JR (1990) Work site smoking cessation: a meta-analysis of long-term quit rates from controlled studies. J Ocupp Med 32:429–439

Goldgruber J (2008) Unternehmenskultur und Gesundheitsförderung. In: Gastager F (ed) Betriebliche Gesundheitsförderung im europäischen Eisenbahnwesen. Böhlau, Wien, pp 189–218

Goldgruber J, Ahrens D (2009) Gesundheitsbezogene Interventionen in der Arbeitswelt. Review über die Wirksamkeit betrieblicher Gesundheitsförderung und Primärprävention. In: Präv Gesundheitsf 4:83–95. doi:10.1007/s11553-008-0155-8

Hey K, Perera R (2005) Competitions and incentives for smoking cessation. (Review). Cochrane Database of Systematic Reviews 2:CD004307. doi:10.1002/14651858.CD004307.pub2

Jordan J, Gurr E, Tinline G, Giga S, Faragher B, Cooper C (2003) Beacons of excellence in stress prevention. research report 133. http://www.hse.gov.uk/research/rrpdf/rr133.pdf [17.07.2008]

Karasek RA (1979) Job demands, job decision latitude, and mental strain: Implications for job redesign. Adm Sci Q 24:285-308

Karasek RA, Theorell T (1990) Healthy work: Stress, productivity, and the reconstruction of working life. Basic Books, New York

Katz DL, O'Connel M, Yeh MC, Nawaz H, Njike V, Anderson LM, Cory S, Dietz W (2005) Public health strategies for preventing and controlling overweight and obesity in school and worksite settings. MMWR 54(RR10):1–12

Kolip P (2006) Evaluation, Evidenzbasierung und Qualitätsentwicklung. Präv Gesundheitsf 1:234–239. doi:10.1007/s11553-006-0042-0

LaMontagne AD, Keegel T, Louie AM, Ostry A, Landsbergis PA (2007) A systematic review of the job-stress intervention evaluation literature, 1990–2005. Int J Occup Environ Health 13:268–280

Lehmann V, Thaler H, Tengg M, Ahrens D (2008) Körperliche Aktivität und Entspannungsverfahren im Betrieb - Übersicht über den Stand der Forschung. In: Gastager F (ed) Betriebliche Gesundheitsförderung im europäischen Eisenbahnwesen. Böhlau, Wien, pp 153–187

Marine A, Ruotsalainen JH, Serra C, Verbeek JH (2006) Preventing occupational stress in healthcare workers. Cochrane Database of Systematic Reviews 4:CD002892. doi:10.1002/14651858.CD002892.pub2

Marshall AL (2004) Challenges and opportunities for promoting physical activity in the workplace. J Sci Med Sport 7:60–66. doi:10.1016/S1440-2440(04)80279-2

Matson-Koffman DM, Brownstein JN, Neiner JA, Greaney ML (2005) A site-specific literature review of policy and environmental interventions that promote physical activity and nutrition for cardiovascular health: what works? Am J Health Promot 19:167–193

McQueen DV (2001) Strengthening the evidence base for health promotion. Health Promot Int 16:261–268

Moher M, Hey K, Lancaster T (2005) Workplace interventions for smoking cessation. (Review). Cochrane Database of Systematic Reviews 2:CD003440. doi:10.1002/14651858.CD003440.pub2

Mulrow CD (1987) The medical review article: state of the science. Ann Intern Med 106:485–488

Nijs KA, de Graaf C, van Staveren WA Kok FJ (2006) Effect of family style mealtimes on quality of life, physical performance, and body weight of nursing home residents: cluster randomised controlled trial. BMJ 332:1180–1184. doi:10.1136/bmj.38825.401181.7C

Novak B, Bullen C, Howden-Chapman P, Thornley S (2007) Blue-collar workplaces: a setting for reducing heart health inequalities in New Zealand. N Z Med J 120:U2708

Parks KM, Steelman LA (2008) Organizational wellness programs: a meta-analysis. J Occup Health Psychol 13:58–68. doi:10.1037/1076-8998.13.1.58

Pigeot I, Ahrens W, Foraita R, Jahn I, Pohlabeln H (2006) Ausgewählte methodische Probleme evidenzbasierter Prävention. Präv Gesundheitsf 1:240–247. doi:10.1007/s11553-006-0036-y

Richardson KM, Rothstein HR (2008) Effects of occupational stress management intervention programs: a meta-analysis. J Occup Health Psychol 13:69–93. doi:10.1037/1076-8998.13.1.69

Rivilis I, Van Eerd D, Cullen K, Cole DC, Irvin E, Tyson J, Mahood Q (2008) Effectiveness of participatory ergonomic interventions on health outcomes: a systematic review. Appl Ergon 39:342–358. doi:10.1016/j.apergo.2007.08.006

Semmer NK, Zapf D (2004) Gesundheitsbezogene Interventionen in Organisationen. In: Schuler H (ed) Enzyklopädie der Psychologie, 2nd ed. Hogrefe, Göttingen, pp 773–843

Seymour JD, Yaroch AL, Serdula M, Blanck HM, Khan LK (2004) Impact of nutrition environmental interventions on point-of-purchase behavior in adults: a review. Prev Med 39:108–136. doi:10.1016/j.ypmed.2004.04.002

Silverstein B, Clark R (2004) Interventions to reduce work-related musculoskeletal disorders. J Electromyogr Kinesiol 14:135–152. doi:10.1016/j.jelekin.2003.09.023

Smedslund G, Fisher KJ, Boles SM, Lichtenstein E (2004) The effectiveness of workplace smoking cessation programmes: a meta-analysis of recent studies. Tob Control 13:197–204. doi:10.1136/tc.2002.002915

Sockoll I, Kramer I, Bödeker W (2008) Wirksamkeit und Nutzen betrieblicher Gesundheitsförderung und Prävention. Zusammenstellung der wissenschaftlichen Evidenz 2000 bis 2006. IGA-Report 13 (BKK BV, DGUV, AOK-BV & AEV, eds.) Essen. http://www.iga-info.de/fileadmin/texte/iga_report_13.pdf [12.8.2009]

Thomson H, Hoskins R, Petticrew M, Ogilvie D, Craig N, Quinn T, Lindsay G (2004) Evaluating the health effects of social interventions. BMJ 328:282–285. doi:10.1136/bmj.328.7434.282

Trojan A (2006) Zu Chancen und Grenzen der Evidenzbasierung komplexer sozialer Interventionen. In: Bödeker W, Kreis J (eds) Evidenzbasierung in Gesundheitsförderung und Prävention. Wirtschaftsverlag NW, Bremerhaven, pp 73–109

Tveito TH, Hysing M, Eriksen HR (2004) Low back pain interventions at the workplace: a systematic literature review. Occup Med 54:3–13. doi:10.1093/occmed/kqg109

Ulich E, Wülser M (2009) Gesundheitsmanagement in Unternehmen. Arbeitspsychologische Perspektiven 3rd ed. Gabler, Wiesbaden

Van der Klink JJL, Blonk RWB, Scheene AH, van Dijk FJH (2001) The benefits of interventions for work-related stress. Am J Public Health 91:270–276

Van der Molen HF, Sluiter JK, Hulshof CT, Vink P, Frings-Dresen MH (2005) Effectiveness of measures and implementation strategies in reducing physical work demands due to manual handling at work. Scand J Work Environ Health 31:75–87

Van Duijvenbode ICD, Jellema P, van Poppel MNM, vanTulder MW (2008) Lumbar supports for prevention and treatment of low back pain. (Review). Cochrane Database of Systematic Reviews 2:CD001823. doi:10.1002/14651858.CD001823.pub3

Van Poppel MNM, Koes BW, Smid T, Bouter LM (1997) A systematic review of controlled clinical trials on the prevention of back pain in industry. Occup Environ Med 54:841–847

Van Poppel MNM, Hooftman WE, Koes BW (2004) An update of a systematic review of controlled clinical trials on the primary prevention of back pain at the workplace. Occup Med 54:345–352. doi:10.1093/occmed/kqh065

Verbeek JH, Salmi J, Pasternack I, Jauhiainen M, Laamanen I, Schaafsma F, Hulshof C, van Dijk F (2005) A search strategy for occupational health intervention studies. Occup Environ Med 62:682–687. doi:10.1136/oem.2004.019117